

Total Ionizing Dose (TID) Test Report for the AD587UQ (5962-8982503PA)

Testing Done October 2003, by Scott Kniffin and Christopher Palor.

A radiation evaluation was performed on **AD587UQ (5962-8982503PA) 10.0V Voltage Reference (Analog Devices)** to determine the total dose tolerance of these parts. The total dose testing was performed using the Co⁶⁰ gamma ray source at NASA GSFC Radiation Effects Facility. During the radiation testing, nine parts were irradiated under bias and one part was used as a control sample. The total dose radiation levels were 2, 4, 6, 8, 10, 12, 16, 20.5, and 24kRads. The average dose rate was ~4.4kRads/day (0.05Rads(Si)/s). After the 24kRad irradiation, the parts were annealed under bias at 25°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table I. An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step. Test procedures and circuit diagrams are included in the memorandum attached. The devices were all marked the same: AD 5692-8982503PA Q 0213 B D12154 on the top and D12154 PHILIPPINES on the bottom.

All parts passed all tests up to 24kRads. After annealing the parts at 25°C for 168 hours, no significant change was noted in any parameter.

Initial electrical measurements were made on 10 samples. Nine samples (SN's 1 to 9) were used as radiation samples while SN 10 was used as a control sample. All parts passed all tests during initial electrical measurements.

Note: During testing, the wrong load resistor was used to test the devices after the 12kRad exposure, this lead to obviously erroneous readings for most of the parameters. The data after the 16kRad exposure confirms acceptable operation of the devices and that the wrong resistor caused no damage to the devices.

All parts passed all tests up to 24kRads.

After annealing the parts for 168 hours at 25°C, no significant change was noted in any parameter.

The separate excel file provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

Table I. Electrical Characteristics AD587

Test #	Parameter	Units	Spec. Limit		Test Conditions
			min	max	
1	Vout (Vin=13.5V)	V	9.99	10.01	Vin=13.5V
2	Vout (Vin=36V)	V	9.99	10.01	Vin=36V
3	Line Regulation	mV	-1.35	1.35	(calculation)
4	Supply Current	mA		4	
5	Vout (no load)	V	9.99	10.01	no load
6	Vout (1k Ω load)	V	9.99	10.01	1k Ω load
7	Load Reg	mV	-1.5	1.5	(calculation)
8	Power Dissipation	mW			(calculation)

UNITED STATES GOVERNMENT

Memorandum

DATE: Sept. 25, 2003

FROM: Christopher Palor

SUBJECT: SECCHI Radiation Test Plan for AD587

TO: Amy Hurley, NRL, Code 8242

This is the test plan for the low dose rate ^{60}Co irradiation to evaluate ELDRS (Enhanced Low Dose Rate Sensitivity) of the AD587 Voltage Reference. Your comments and suggestions are invited before we begin the actual irradiation.

Part Under Test:

AD587 Low Noise, Precision Voltage Reference

Manufacturer: Analog Devices

Each part has the following printed information:

On front:

On back:

The parts are serialized (SN) by the manufacturer, and our chip identification (chip#) to SN will be as shown in Table 1 below.

Chip#	1	2	3	4	5	6	7	8	9	10
SN										

Table 1: Assigned chip# and manufacturer SN association.

The AD587 Low Noise, Precision Voltage Reference will be irradiated with ^{60}Co gamma rays at a dose rate of 0.05 rads(Si)/sec (~4.4 krad(Si)/day). The parts will be irradiated at room temperature, and during the irradiation the electrical parameters will be measured as a function of total ionizing dose. The planned data collection points are: Pre-irradiation, 2 krad(Si), 4 krad(Si), 6 krad(Si), 8 krad(Si), 10 krad(Si), 12 krad(Si), 16 krad(Si), 20 krad(Si), and 24 krad(Si).

Figure 1 shows a schematic diagram of the irradiation bias condition. $V1=15$, $R1=1\text{Kohm}$ (for an output current of 10mA).

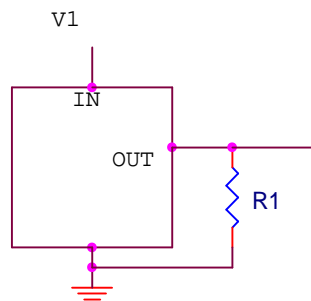


Figure 1: Schematic of the irradiation bias condition.

A total of 10 parts will be irradiated using the Goddard Space Flight Center ^{60}Co gamma ray source. And following

irradiation (at each dose point) the following parameters will be measured:

- 1) Output Voltage
- 2) Supply Current
- 3) Line Regulation
- 4) Load Regulation
- 5) Quiescent Current
- 6) Power Dissipation

Methods:

I). Line Regulation:

To measure the line regulation, a 10 second pulse will be applied to the part and a measurement will be taken in the middle of the pulse. A voltmeter with nV readout capability will be used to compare the output voltages. The first output measured will be with an input of 13.5V and the second measurement will be with an input of 36V. The difference between the two measurements will be calculated to determine the line regulation parameter.

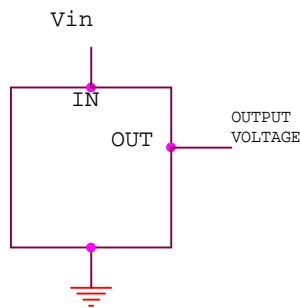


Figure 2. Test set-up for Line Regulation

Note:

$V_{in} = 13.5V$ then $36V$

Measure output voltages for two different inputs. The difference equals the Line Regulation.

II). Load Regulation:

The measurement of load regulation will use the same test method as line regulation, except a load will be added. The first measurement will be with a 10 second pulse without a load and the second measurement will be with a 10 second pulse with a $1k\Omega$ load (for a sourcing current of 10.0mA). The spec sheet allows a maximum of 100uV/mA.

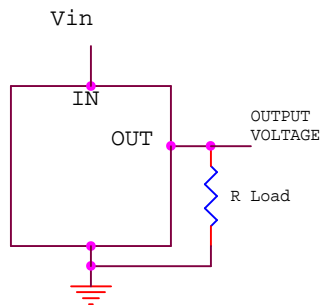


Figure 3. Test Set-up for Load Regulation

Note:

$V_{in} = 15V$

Measure output voltages first with no load then with $R_{Load} = 1k\Omega$. The difference equals the Load Regulation.

III). Supply Current/Quiescent Current, Output Voltage and Power Dissipation.

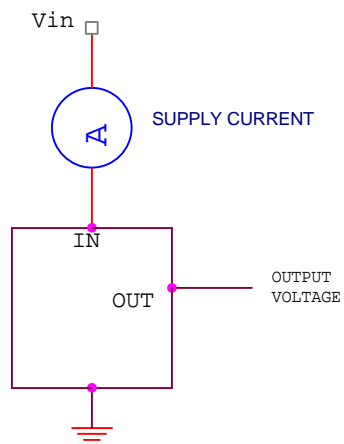


Figure 4. Test Set-up to measure the Supply Current/Quiescent Current, Output Voltage and Power Dissipation.

Note:

$$\text{Power Dissipation} = V_{in} * \text{Supply Current}$$

Table 2: Typical data-logging table for AD587, chips #1 to 10 shown.

The test report will provide a summary of the part information, summarize the radiation data, explain the measurement techniques, provide tabular and graphical comparisons of the data from pre-irradiation and each radiation dose step for each of the voltage references with comparison to the manufacturer's spec limits, and contain an appendix of the raw radiation data.

Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD587 (1)

Test #	Parameters	Units	Spec. Lim. (2)		Total Dose Exposure (kRads Si)																				Annealing	
					Initial		2		4		6		8		10		12 (3)		16		20.5		24		168 hours @25°C	
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Vout (Vin=13.5V)	V	9.99	10.01	10.0012	0.00131	10.0008	0.0013	10.001	0.00128	10.0013	0.00131	10.001	0.00123	10.0009	0.00131	9.1176	0.00287	10.001	0.00126	10.0011	0.00118	10.0012	0.00121	10.0011	0.00123
2	Vout (Vin=36V)	V	9.99	10.01	10.0014	0.00131	10.0011	0.00131	10.0013	0.00131	10.0016	0.00131	10.0013	0.00126	10.0012	0.00131	10.0014	0.00131	10.0014	0.00127	10.0014	0.00118	10.0015	0.00119	10.0013	0.00122
3	Line Regulation	mV	-1.35	1.35	0.30	2.0E-02	0.29	2.0E-02	0.31	2.1E-02	0.32	1.9E-02	0.31	3.8E-02	0.32	2.2E-02	883.8	2.76	0.36	1.9E-02	0.35	1.7E-02	0.35	1.8E-02	0.19	4.5E-02
4	Supply Current	mA		4	1.42	3.E-08	1.42	3.E-08	1.42	3.E-08	1.42	3.E-08	0.855	1.12	0.57	1.27	1.42	3.E-09	1.42	3.E-08	1.14	0.85	1.14	0.85	1.14	0.85
5	Vout (no load)	V	9.99	10.01	10.0013	0.00131	10.001	0.00131	10.0012	0.0013	10.0015	0.00131	10.0012	0.00126	10.0011	0.0013	9.12322	0.00295	10.0013	0.00126	10.0013	0.00119	10.0014	0.00122	10.0012	0.00122
6	Vout (1kW load)	V	9.99	10.01	10.001	0.00133	10.0007	0.00132	10.001	0.0013	10.0011	0.00126	10.0009	0.00127	10.0008	0.00135	8.70155	0.00941	10.0012	0.00127	10.0012	0.00119	10.0013	0.00118	10.001	0.00129
7	Load Reg	mV	-1.5	1.5	0.30	3.2E-02	0.24	3.1E-02	0.21	2.1E-02	0.37	6.0E-02	0.28	6.5E-02	0.33	9.4E-02	421.7	6.5	0.09	7.6E-02	0.14	2.2E-01	0.09	2.9E-01	0.21	2.4E-01
8	Power Dissipation	mW			21	0	21	0	21	0	21	0	13	16.8	9	19.1	14	0	21	0	17	12.7	17	12.7	17	12.7

Notes:

- (1) The mean and standard deviation values were calculated over the nine parts irradiated in this testing. The control sample remained constant throughout testing and is not included in this table.
- (2) These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
- (3) An incorrect load resistor was used for these measurements. The values presented do not reflect the actual operating conditions of the devices and are presented solely for the sake of completeness.

Radiation sensitive parameters: None.